BLOWER ASSEMBLY AND METHOD

Background of the Invention

Many different blower assemblies exist and are well known in the art. A typical centrifugal blower assembly includes a scroll-shaped housing having a fan enclosed therein, and a motor assembly mounted to the housing and drivably coupled to the fan. In many cases, the housing includes a centralized intake opening to allow the fan to draw air from outside the housing, and a discharge opening substantially transverse to the intake opening and from which pressurized air is discharged by the fan.

The motor assembly typically includes an electric motor mounted to the housing. A bracket can support the motor such that the motor's driveshaft extends through an opening in the housing to drive the fan. The driveshaft is coupled to the fan using conventional methods such that torque from the driveshaft is transmitted to the fan to drive the fan.

The electric motor is controllable to drive the fan at one or more speeds. As such, any imbalance in the fan or misalignment between the driveshaft and the fan can cause vibration to be transmitted through the motor assembly to the housing. If the housing is rigidly mounted to its supporting structure, the vibration can be further transmitted to the supporting structure and beyond. Vibration of the fan assembly or its supporting structure can cause noise, premature failure, and other problems (common in some conventional fan assemblies).

To help dampen fan assembly vibration (in those embodiments where such dampening is desired), the motor assembly can be isolated from the housing by one or more resilient bushings. Typically, the resilient bushing is fastened to the housing, and the bracket is independently coupled to the resilient bushing to isolate the bracket from the housing. Conventional multi-piece fasteners (e.g., a bolt, washer, and nut) are typically used to fasten the resilient bushings to the housing. However, such conventional manners of attachment can loosen over an extended period of time, which can lead to damage and/or failure of the blower assembly. Also, the head portion of many conventional fasteners typically extends too far into the housing, such that it can physically interfere with the fan or disrupt the airflow in the housing generated by the fan.

Other fasteners, such as self-clinching enlarged head studs or capacitor discharge (CD) welded studs, can be employed to help decrease the interference and disruption inside the housing caused by other fasteners. However, many such alternative fastening elements are

difficult to install and secure and/or can add significant cost in the assembly process. Also, in many cases the resilient bushing is still captured by a washer and nut, which can loosen from the stud over an extended period of time.

Other issues important to blower design include blower manufacturability and the costs associated with blower assembly. Blower designs that take these issues into account while providing good fan performance are always welcome in the art.

Summary of the Invention

In some embodiments of the present invention, a blower assembly is provided, and has a housing adapted to receive a fan therein, a bracket coupled to the housing, a motor supported on the bracket and drivably coupled to the fan, a resilient bushing coupled to the housing and positioned to support the bracket thereon, and a one-piece fastener coupling the resilient bushing to the housing, wherein the one-piece fastener includes a first retaining portion and a second retaining portion, and wherein the resilient bushing and at least a portion of the housing are secured between the first retaining portion and the second retaining portion.

Some embodiments of the present invention provide a blower assembly comprising a housing adapted to receive a fan, a bracket coupled to the housing, a motor supported on the bracket and drivably coupled to the fan, a resilient bushing coupled to the housing and positioned to support the bracket, a permanently deformable fastener coupling the resilient bushing to the housing, wherein the permanently deformable fastener includes a head and a deformable shank extending from the head, and wherein the resilient bushing and at least a portion of the housing are secured between the head and a deformed end portion of the shank.

In another aspect of the present invention, a blower assembly is provided that has a housing adapted to receive a fan therein, a bracket coupled to the housing, a motor supported on the bracket and drivably coupled to the fan, a resilient bushing coupled to the housing and positioned to support the bracket, and a permanently deformable fastener coupling the resilient bushing to the housing, wherein the permanently deformable fastener includes a head and a deformable shank protruding from the head, and where at least a portion of the shank is deformed to secure the resilient bushing between the housing and the head.

In yet another aspect of the present invention, a method of securing a motor assembly to a fan housing is provided, and comprises providing a resilient bushing, positioning the resilient

bushing at a mounting portion of the housing, providing a permanently-deformable fastener having a head and a deformable shank extending from the head, inserting the permanently-deformable fastener through the resilient bushing and the mounting portion of the housing, and deforming an end portion of the shank such that the resilient bushing and the mounting portion of the housing is secured between the head and the deformed end portion of the shank.

Other features and aspects of the present invention will become apparent to those skilled in the art upon review of the following detailed description, claims and drawings.

Brief Description of the Drawings

In the drawings, wherein like reference numerals indicate like parts:

FIG. 1 is a perspective view of a blower assembly according to an exemplary embodiment of the present invention, illustrating a motor assembly mounted to a housing;

FIG. 2 is a cross-sectional view of a portion of the exemplary blower assembly of FIG. 1, taken along lines 2-2 of FIG. 1; and

FIG. 3 is a cross-sectional view similar to that of FIG. 2, showing a mounting configuration according to another exemplary embodiment of the present invention.

Before any features of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangements of supports set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

Detailed Description

With reference to FIG. 1, a exemplary blower assembly 10 including a motor assembly 14 coupled to a housing 18 is shown. The motor assembly 14 includes an electric motor 22 mounted to a bracket 26 having multiple resilient bushings 30 secured thereto. In the illustrated construction, the bracket 26 includes three resilient bushings 30 to provide three mounting locations to the housing 18. However, in other constructions of the blower assembly 10, more or less than three resilient bushings 30 can be used to provide more or less than three mounting locations to the housing 18. Further, in other constructions of the blower assembly 10, the

resilient bushings 30 can be omitted from the motor assembly 14 such that the bracket 26 is rigidly mounted to the housing 18 (as described in greater detail below). The motor 22 can comprise a conventional AC or DC electric motor 22 powered by either an AC or DC power source (not shown), respectively. Alternatively, any other driving device capable of driving a fan (as described in greater detail below) can instead be employed, such as hydraulic motors, magneto-drives, and the like, any of which can be mounted to a housing 18 following the same principles of the invention described herein.

With reference again to the exemplary illustrated embodiment, the motor 22 includes a driveshaft (not shown) extending therefrom and a cooling fan 34 coupled for co-rotation with the driveshaft. Upon activation of the motor 22 and rotation of the driveshaft, the cooling fan 34 provides a cooling airflow past the motor 22. In other embodiments, the driveshaft is only coupled to a fan within the housing 18 (i.e., no cooling fan 34 is employed).

The motor 22 is supported by the bracket 26 relative to the housing 18 such that the driveshaft extends through an opening (not shown) in the housing 18. The driveshaft is coupled to a fan 38 inside the housing 18 using conventional methods such that torque from the driveshaft is transmitted to the fan 38 in order to drive the fan 38.

With reference to FIG. 2, a first exemplary mounting configuration of the motor assembly 14 is shown. The resilient bushing 30 in this embodiment is configured as a hollow cylinder defining an outer surface 42 and a central aperture 46 therethrough. The bushing 30 defines a length dimension along a longitudinal axis 48 passing through the central aperture 46. In other embodiments, the resilient bushing 30 can take any other shape desired (i.e., not necessarily cylindrical or fully encircling the rivet). Resilient bushings 30 having any shape capable of being retained in place with respect to the housing 18 (e.g., C-shaped bushings, ring-shaped bushings, and the like) can instead be employed. In some embodiments, the resilient bushing 30 includes a groove 50 to receive a mating flange, edge, or protrusion 54 of the bracket 26. The groove 50 can extend along and/or around any part of the resilient bushing 30 in order to provide engagement between the bracket 26 and the resilient bushing 30. The resulting connection between the flange, edge, or protrusion 54 and the groove 50 is sufficient to secure the resilient bushing 30 to the bracket 26. In other embodiments, a groove 50 is not needed to secure the bracket 26 to the resilient bushing 30. Rather, the bracket 26 can be pressed onto the bushing 30 to achieve the connection between the bracket 26 and the bushing 30 and/or the

bracket 26 can be connected to the bushing 30 with epoxy or other bonding material, or in any other manner.

The resilient bushings 30 can be made of any material or combination of materials, including without limitation rubber, plastic, urethane, and any other vibration dampening material. In other embodiments, the bushing 30 need not necessarily be selected for vibration dampening properties, such as bushings 30 manufactured of steel, aluminum, brass, and other metals, ceramics, composite materials, and the like, in which case the bushing 30 can even be an integral part of the bracket 26 and can have any other shape desired. In such cases, the bushings 30 can be employed for securing the bracket 26 in a desired location with respect to the housing 18, can have electrically insulative or conductive properties, can have heat insulative or conductive properties, and the like.

A one-piece, permanently deformable fastener 58 is insertable through the aperture 46 of the resilient bushing 30 and an aperture 62 formed in the housing 18. The fastener 58 is further secured to the housing 18 so that the resilient bushing 30 is secured to the housing 18. The fastener 58 is secured to the housing 18 by deforming at least one end of the fastener 58 with a tool (not shown). Any tool capable of deforming the end of the fastener 58 can be employed for this purpose. By way of example only, a tool designed to grasp one end of the fastener 58 and deform the opposite end can be employed, if desired. As shown in FIG. 2, the fastener 58 includes a first retaining portion, or a head 66, and a second retaining portion, or a deformed end portion 70 of a shank 74 extending from the head 66. The head 66 is positioned outside the housing 18, while the deformed end portion 70 is positioned inside the housing 18. However, in other embodiments, the fastener 58 can be reversed, such that the head 66 is positioned inside the housing 18 and the deformed end portion is positioned outside the housing 18 adjacent the tubular support 82 and the resilient bushing 30. In such cases, a washer or similar element can be employed on an end of the fastener 58 opposite the head 66 as needed.

In the illustrated construction of FIG. 2, the fastener 58 is shown having a partially hollow shank portion 78. After the shank 74 is inserted through the resilient bushing 30 and the aperture 62 formed in the housing 18 as described above, the partially hollow shank portion 78 can be deformed outwardly to yield the deformed end portion 70. However, in other constructions of the blower assembly 10, the shank 74 can be entirely solid rather than being partially hollow, or can be entirely hollow along the length of the shank 74.

In the illustrated exemplary embodiment, a tubular support 82 is also employed to mount the bracket 26 to the housing 18. The tubular support 82 shown in FIG. 2 is received within the resilient bushing 30, at least partially surrounds the fastener 58, and includes a base 86 and a hollow shank 90 extending from the base 86. The hollow shank 90 defines a length dimension along the longitudinal axis 48. One side of the base 86 abuts an outside surface 94 of the housing 18, while the resilient bushing 30 is slidably inserted over the hollow shank 90 and abutted against the opposite side of the base 86. However, in other embodiments, the tubular support 82 can be reversed, such that the base 86 is positioned adjacent the head 66. In still other embodiments, the tubular support 82 is received within the aperture 62 in the housing 18 such that the wall of the housing 18 is trapped between the base 86 and the bushing 30.

In some embodiments, the tubular support 82 is used to prevent buckling of the fastener 58 and to limit the amount which an installation tool (not shown) can compress the fastener 58. As a result, the tubular support 82 can have any of a number of shapes capable of preventing buckling of the fastener 58 (e.g., a straight tube without an enlarged end, a tapered lug, and the like). The resilient bushing 30 can be sized with a length dimension (i.e., along an axis parallel to the shank 90) that is no shorter than the length of the hollow shank 90 of the tubular support 82. In some cases, the length of the resilient bushing 30 is longer than that of the hollow shank 90, thereby providing a pre-loaded resilient bushing 30.

In the illustrated exemplary construction, the shank 74 of the fastener 58 is inserted through the hollow shank 90 of the tubular support 82 and the aperture 62 formed in the housing 18. The hollow shank 90 of the tubular support 82 can provide structural reinforcement and stability to the shank 74 of the fastener 58. For instance, the hollow shank 90 of the tubular support 82 can help prevent the shank 74 of the fastener 58 from buckling under applied loads (e.g., stress placed upon the bracket 26, compression forces placed upon the shank 74 of the fastener 58 during the fastening process, and the like). The length dimension of the resilient bushing 30, the length of the hollow shank 90 of the tubular support 82, and the length of the shank 74 of the fastener 58 can be sized such that upon deforming the fastener 58 to secure the bracket 26 to the housing 18, the head 66 is drawn against the hollow shank 90 of the tubular support 82. However, in other constructions of the blower assembly 10, the tubular support 82 is omitted, such that the resilient bushing 30 is abutted against the surface 94 of the housing 18.

The one-piece, deformable fastener 58 can allow for a simplified method of assembling the motor assembly 14 to the housing 18. In this regard, the motor assembly 14 can be pre-assembled before being assembled with the housing 18. Any of a number of differently sequenced steps can be carried out to pre-assemble the motor assembly 14. One such method of pre-assembling the motor assembly 14 includes coupling the electric motor 22 to the bracket 26, then coupling the cooling fan 34 to the driveshaft. The motor 22 can be coupled to the bracket 26, and the cooling fan 34 coupled to the driveshaft in any conventional manner.

Each resilient bushing 30 can be coupled to the bracket 26 by engaging the groove 50 formed in the resilient bushing 30 with the mating flange, edge, or protrusion 54 in the bracket 26 as described above. This can be performed at any time during pre-assembly of the motor assembly 14 (i.e., before, concurrently, or after coupling the motor 22 and the bracket 26) or at another time. If employed, the tubular support 82 can also be engaged with the resilient bushing 30 while pre-assembling the motor assembly 14. However, the tubular support 82 can instead be engaged with the resilient bushing 30 during a separate step after pre-assembling the motor assembly 14.

In those embodiments in which the motor assembly 14 is pre-assembled, the pre-assembled motor assembly 14 can be positioned such that each resilient bushing 30 is positioned relative to (e.g., over) a respective aperture 62 formed at an outside surface 94 or other mounting portion of the housing 18. If one or more tubular supports 82 are pre-assembled with the motor assembly 14, then the motor assembly 14 can be positioned such that the tubular supports 82 (e.g., the bases 86 of the tubular supports 82) abut the housing 18 and the central aperture 46 of the resilient bushing 30 is aligned with the aperture 62 formed in the housing 18.

After positioning the resilient bushings 30 adjacent apertures 62 in the housing 18, the shanks 74 of the fasteners 58 are inserted through the resilient bushings 30 (and the hollow shanks 90 of the tubular support 82, if employed) and through the apertures 62 formed in the housing 18, such that the head 66 of the fastener 58 is located outside of the housing 18. With reference to the illustrated exemplary embodiment of FIGS. 1 and 2, the partially-hollow shank portion 78 is then deformed as described above. The act of deforming the partially-hollow shank portion 78 can pre-load the resilient bushing 30 until the head 66 abuts against the hollow shank 90 of the tubular support 82, if employed. Otherwise, the partially-hollow shank portion 78 can be deformed until the fastener 58 has been shortened to a desired length (in some cases pre-

loading the resilient bushing 30 and in other cases only retaining the resilient bushing in place with respect to the housing 18). As previously stated, the fastener 58 can instead be reversed, such that the head 66 is positioned inside the housing 18 and the deformed end portion is positioned outside the housing 18 adjacent the tubular support 82 and the resilient bushing 30. The fan 38 can be coupled to the driveshaft of the motor 22 in any conventional manner.

The one-piece, deformable fastener 58 illustrated in FIG. 2 can simplify the process of assembling the motor assembly 14 with the housing 18 by decreasing the number and complexity of assembly steps required (compared to conventional assembly methods). In some cases for example, bolts, self-clinching enlarged head studs, or CD welded studs must be inserted from the inside of the housing 18. In the case of CD welded studs, a welding step follows the insertion step to secure the CD welded studs to the housing 18. Further, after the motor assembly 14 is positioned on the housing 18, a step is often required to insert washers onto the bolts or studs, and a step is required to thread nuts onto the bolts or studs to secure the motor assembly 14 to the housing 18. In some embodiments of the present invention, such steps are not required, and are less complex that the actions taken to secure the motor assembly to the housing 18 as described above.

The one-piece, deformable fastener 58 illustrated in FIG. 2 also decreases the number of components used to assemble the motor assembly 14 and the housing 18. The method according to some embodiments of the present invention requires only a single component (i.e., the fastener 58) to secure each resilient bushing 30 to the housing 18, while conventional methods require multiple components (e.g., a bolt or stud, a washer, and a nut) to secure each resilient bushing 30 to the housing 18. This reduction of components decreases costs relating to assembling the blower assembly 10, which can result in increased profitability for the manufacturer.

The deformable fastener 58 illustrated in FIG. 2 can also increase the reliability of the connection between the motor assembly 14 and the housing 18. Once the fastener 58 is deformed, the connection between the motor assembly 14 and the housing 18 is permanent. In contrast, by using conventional motor assembly mounting methods, a nut or other fastening element can loosen due to excessive vibration of the blower assembly 10. A soft-foot condition can result and cause additional vibration of the blower assembly 10. Failure of the blower assembly 10 can even result if the fasteners are continually allowed to loosen.

By virtue of the shape of the fastener 58, the deformed end portion 70 (or the head 66, in some embodiments) can occupy relatively little space inside the housing 18 (see FIG. 2), thereby providing increased clearance between the fastener 58 and the fan 38 while decreasing undesirable characteristics in the airflow inside the housing 18.

With reference to FIG. 3, a second exemplary mounting configuration of the motor assembly 14 is shown. In this embodiment, the resilient bushing 30 is configured and secured to the bracket 26 in a manner similar to that shown in FIG. 2, with the exception of the fastener structure employed. Accordingly, with the exception of mutually inconsistent elements and features between the embodiments of FIGS. 2 and 3, reference is made to the above discussion regarding the embodiment illustrated in FIG. 2 for further description regarding the elements, features, and fastening process of the embodiment illustrated in FIG. 3.

With reference to FIG. 3, some embodiments of the present invention employ a fastener 102 received through the resilient bushing 30 and permanently deformable to engage the resilient bushing 30 or another element received within the resilient bushing 30. In the illustrated embodiment of FIG. 3, a tubular support 98 is also received within the resilient bushing 30, and receives the fastener 102 for this engagement. In some embodiments, the tubular support 98 includes a base 106 and a hollow shank 110 extending from the base 106 and defining a length dimension along the longitudinal axis 48. The hollow shank 110 is insertable through the aperture 62 in the housing 18 such that the base 106 abuts an inside surface 114 of the housing 18. The resilient bushing 30 is inserted over the hollow shank 110 and is abutted against an outside surface 94 of the housing 18.

With continued reference to the exemplary illustrated embodiment of FIG. 3, the permanently deformable fastener 102 can be inserted through the hollow shank 110 of the tubular support 98. As shown in FIG. 3, the fastener 102 includes a head 122 and a shank 126 extending from the head 122 and defining a length dimension along the longitudinal axis 48. The fastener 102 is secured to the hollow shank 110 so that the resilient bushing 30 is secured to the housing 18. At least an end portion 130 of the shank 126 is deformable by a mandrel 134 extending through the shank 126 and the head 122. Upon insertion with the tubular support 98, the head 122 is positioned outside the housing 18, while the end portion 130 is positioned inside the hollow shank 110 of the tubular support 98. The fastener 102 is secured to the hollow shank 110 by permanently deforming the end portion 130 of the shank 126 with a tool capable of

grasping and pulling the mandrel 134 from the shank 126. A friction or interference fit between the deformed end portion 130 of the shank 126 and the hollow shank 110 of the tubular support 98 is sufficient to interlock the fastener 102 and the tubular support 98, thereby securing the resilient bushing 30 to the housing 18.

In other embodiments, the tubular support 98 and the fastener 102 illustrated in FIG. 3 can be reversed, such that the head 122 of the fastener 102 is positioned inside the housing 18 and the base 106 of the tubular support 98 is positioned outside the housing 18 adjacent the resilient bushing 30. In still other embodiments, the tubular support 98 can be omitted. In such embodiments, the fastener 102 is insertable through the aperture 62 in the housing 18 such that the head 122 abuts the inside surface 114 of the housing 18. The resilient bushing 30 can then be inserted over the shank 126 and is abutted against the outside surface 94 of the housing 18. Further, the mandrel 134 can be pulled from the shank 126 to deform the end portion 134 of the fastener 102 to substantially interlock the bushing 30 and the fastener 102, thereby securing the bushing 30 to the housing 18.

The embodiments described above and illustrated in the figures are presented by way of example only and are not intended as a limitation upon the concepts and principles of the present invention. As such, it will be appreciated by one having ordinary skill in the art that various changes in the elements and their configuration and arrangement are possible without departing from the spirit and scope of the present invention as set forth in the appended claims.

For example, and as mentioned above, some embodiments of the blower assembly 10 employ no resilient bushings 30 to mount the motor assembly 14 to the housing 18. By way of example only, the embodiment of the present invention illustrated in FIG. 2 can be modified such that no bushing 30 is employed, such as by reducing the aperture in the bracket 26 so that the head 66 of the fastener 58 retains the bracket 26 on the housing 18. In these embodiments, the bracket 26 can be secured in place with respect to the housing 18 in a number of different manners, such as by shortening the fastener 58 such that the bracket 26 is in contact with the housing 18, trapping the bracket 26 between the head 66 of the fastener 58 and the adjacent end of the tubular support 82, receiving the bracket 26 inside a groove or other recess in the fastener 58, and the like. Still other manners of securing the bracket 26 with respect to the housing 18 are possible, and fall within the spirit and scope of the present invention.

Another example of alternative embodiments falling within the present invention relates to the use of the tubular support 90 to secure the bracket 26 to the housing 18. In particular, in some embodiments the fastener 58 (referring to the embodiment illustrated in FIG. 2) is integral with the tubular support 90. In such embodiments, the tubular support 90 need not necessarily have a base 86, and can instead extend through the wall of the housing 18 to a side opposite the bracket 26. The wall(s) of the tubular support 90 can therefore extend to and intersect the surface 94 of the housing 18 (whereby a portion of the tubular support 90 extends further through the aperture 62). The tubular support 90 can then be secured with respect to the housing 18 by employing a tool (not shown) to deform the end of the tubular support 90 received through the housing wall in a manner similar to that described above with reference to the deformation of the fastener 58 in FIG. 2 (i.e., emulating the illustrated deformed end portion 70 of the fastener 58 in FIG. 2).